

11. METABOLISM OF YEAST

How does the amount of available dissolved oxygen affect the metabolic pathway used by yeast?

Objectives

- Compare the respiration rate of yeasts under aerobic and anaerobic conditions.
- Explain how yeasts benefit from dual metabolic pathways.

Materials and Equipment

- Data collection system
- Carbon dioxide gas sensor with sampling bottle
- Balance (Readability: 0.01 g)
- Beaker, 250-mL
- Graduated cylinder, 10-mL
- Graduated cylinder, 100-mL
- Scoopula
- Stirring rod
- Weighing dish
- Sodium sulfite (Na_2SO_3), 0.15 g
- Active yeast suspension, 10 mL
- Sugar water, 150 mL
- Wash bottle filled with distilled water

Safety

Follow these important safety precautions in addition to your regular classroom procedures:

- Wear safety goggles at all times.
- Wash your hands thoroughly after completing the investigation.

Procedure

1. Select Sensor Data in SPARKvue.
2. Connect the carbon dioxide (CO_2) gas sensor to your device. Calibrate the sensor.
3. Choose the Graph template.
4. Stir the yeast suspension; measure 5 mL and add it to the bottle.
5. Add 75 mL of sugar water to the bottle. Swirl to mix, set the bottle down and loosely seal the bottle with the CO_2 gas sensor as shown in Figure 1.

Note: Do not let the sensor get wet!

6. Select Start to begin collecting data. Record the initial CO_2 gas concentration in Table 1.
7. Allow data collection to continue for 3 minutes. Do not disturb the system during data collection.
8. Stop collecting data after 3 minutes. Record the final CO_2 gas concentration and time elapsed in Table 1.



Figure 1: Seal the bottle with the sensor

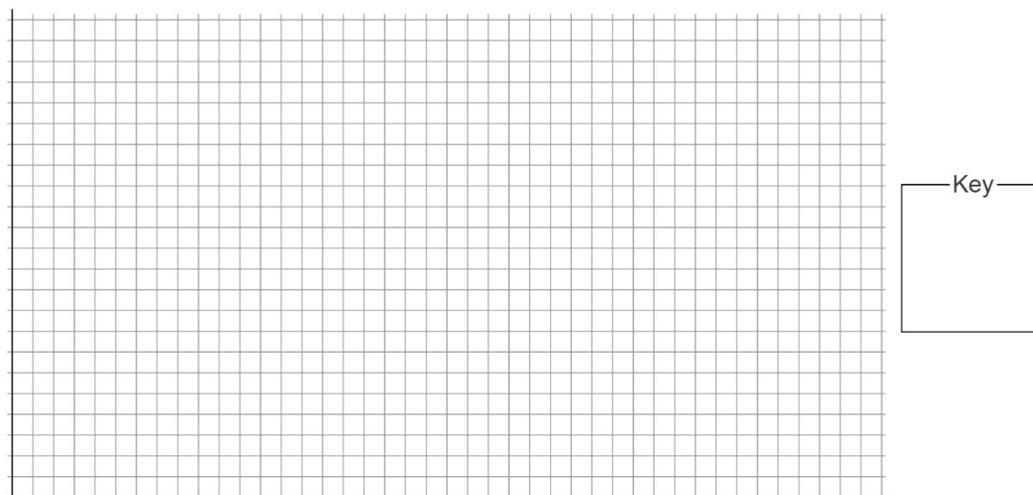
9. Remove the sensor from the bottle. Dispose of the contents as directed by your instructor. Rinse the bottle and shake it to remove excess water.
10. Measure 0.15 g of sodium sulfite (Na_2SO_3) and add it to a beaker.
11. Rinse the stirring rod thoroughly. Add 75 mL sugar water to the beaker and stir until all of the Na_2SO_3 is dissolved. The purpose of the Na_2SO_3 is to absorb excess oxygen from the water, creating a low-oxygen sugar water solution.
12. Repeat Steps 4-9 substituting using the low-oxygen sugar water solution.
13. Show both runs in SPARKvue and scale the display. Sketch your results in Graph 1. Include numbers, labels, and units on the x- and y-axes. Add a key to identify each run.
14. Use the following equation to find the change in CO_2 concentration; record the result in Table 1.
Change in CO_2 concentration = Final CO_2 concentration - Initial CO_2 concentration
15. Use the following equation to calculate the CO_2 gas production rate; record the result in Table 1.
 CO_2 gas production rate (ppm/s) = Change in CO_2 concentration (ppm) \div Time (s)

Data Collection

Table 1: Comparison of CO_2 produced in regular and low-oxygen conditions

Type of Sugar Solution	Initial CO_2 Concentration (ppm)	Final CO_2 Concentration (ppm)	Time Elapsed (s)	Change in CO_2 Concentration (ppm)	CO_2 Gas Production Rate (ppm/s)
Regular					
Low-oxygen					

Graph 1: CO_2 produced in regular and low-oxygen conditions



Questions and Analysis

1. How does the rate of CO₂ production under regular oxygen conditions compare to the rate of CO₂ production under low oxygen conditions?
2. What can you conclude about the effect of low oxygen levels on yeast respiration? What additional event could be occurring in the bottle under the low-oxygen condition? Support your answer with data from this investigation.
3. If yeast are facultative anaerobes and are crucial in the making of products like beer and wine under low oxygen conditions, are there still yeast living in those products when someone consumes them?
4. Explain how the ability to perform either aerobic or anaerobic respiration is advantageous to organisms like yeast as well as other organisms that are not capable of anaerobic respiration.
5. In this investigation you used a CO₂ gas sensor to determine the aerobic respiration rate of yeast under different oxygen conditions. How would you modify the procedure to determine whether the *anaerobic* respiration rate in yeast is higher under regular oxygen conditions or low oxygen conditions?